

1. IDENTIFICATION INFORMATION

1.1 Citation

Originator: Maryland Department of Environment (MDE)

Publication Date: 1998

Title: Maryland Ground Water Balance Database

Publication Information

Publication Place: Annapolis, Maryland

Publisher: Maryland Department of Environment, Water Rights Division (WRD)

1.2 Description

Abstract: This statewide watershed-oriented database contains groundwater supply and use information in digital form from a number of sources, comprising essentially five major source files: (1) the revised 1997 Maryland Department of Natural Resources (DNR) eight digit watershed file and related INRA (Integrated Natural Resources Assessment) data; (2) U.S. Geological Survey (USGS) collected water use information for the period 1990-present; (3) Maryland Department of Environment (MDE) water use information from the Water Rights Division (WRD); (4) Maryland Office of Planning (OP) 1994 land use information and updated 1990 Census data; and (5) U.S. Department of Commerce (USCOM), National Oceanic Atmospheric Administration (NOAA) hydrological data for 1980-present. Information contained within this database is for the designated second level or sub-watershed level which encompasses 138 watersheds. The Chesapeake Bay, rather than being one hydrological unit, has been subdivided into three hydrologic units for purposes related to Departmental responsibilities. A fourth hydrologic unit is the Atlantic Ocean. Variables within the database have been obtained by essentially intersecting statewide data on a county basis and then allocating variables to watersheds based upon acres of watershed within the County or by assigning regional and point data to watersheds. Several variables in the database, derived from digital files and hard copy reports previously distributed in other watershed oriented databases from other sources, have also been used in the database.

Purpose: This database will be used to analyze the importance of ground water supply and use within the context of the DNR's developing INRA and for departmental purposes within MDE. It will be used to analyze water use and other information related to natural resources in the state and relationship to the Assessment. It will also be used in conjunction with other databases to measure cumulative impacts of growth and development upon the state's natural resources, particularly in reference to habitat loss and in terms of water use related to economic development. It will be used with other databases to undertake qualitative and quantitative ecological risk assessment and ranking of watershed similarities and differences.

1.3 Time Period of Content

1933-1997

1.4 Status

Progress: Ongoing

Maintenance and update frequency: Irregular

1.5 Spatial Domain

Bounding Coordinates

West Bounding Coordinate: -79.4938

East Bounding Coordinate: -75.0405

North Bounding Coordinate: 39.7425

South Bounding Coordinate: 37.8713

1.6 Keywords

Theme

Theme Keyword Thesaurus: None

Theme Keyword: Watershed

Theme Keyword: Ground Water Supply

Theme Keyword: Water Supply and Use

Place

Place Keyword Thesaurus: None

Place Keyword: Maryland

Place Keyword: Watershed

1.7 Access Constraints: None

Use Constraints: This watershed-oriented database represents the results of data collection and processing for specific Maryland Department of Environment (MDE) and Department of Natural Resources (DNR) planning activities and indicates generalized existing conditions for a certain time period as referenced in the metadata database form. As such, it is only valid for this intended use and time. The user is responsible for the results of any application of the data for other than their intended purpose. The information contained in this database is from publicly available sources, but no representation is made as to the accuracy or completeness of the data. Acknowledgement of the Maryland MDE and DNR is requested for products derived from the data.

1.8 Cross reference data

Citation: SHED1997

Originator: Maryland Department of Natural Resources (DNR)

Publication Date: 19970327

The SUB1997 file is a dissolved version of SHED1997. This file was created by removing and dissolving by the MDE8DIGT code to form unique polygons at the eight digit level.

Title: SUBS1997 Alias file names for this file:

swSUBS7f.e00 - ARC Export waterSUBS file in state plane 27 feet

swSUBS3f.e00 - ARC Export waterSUBS file in state plane 83 feet

swSUBS3m.e00 - ARC Export waterSUBS file in state plane 83 meters

swSUBS3m.dig - Digital Line Graph waterSUBS file in state plane 83 meters

All references to SUBS1997 apply to all the aliases except for the above reference to projection. These files can not be renamed except during importing.

2. DATA QUALITY INFORMATION

2.1 Attribute Accuracy:

Attribute Accuracy Report: Attributes from the various data layers were compared with the original thematic data to verify that no attributes were generated that should not exist. Numbers and acreages derived of different variables were compared with source hardcopy and other reports. Rounding errors for variables were compared with original source data to determine a degree of error. When watershed totals for the state were compared with state totals from the various source data, rounding errors occurred. In a number of variables rounding errors were found but not considered substantial to affect database use. For the four hydrologic units comprising the Chesapeake Bay and Atlantic Ocean, there is some ground water consumption reported but because of zero discharge, variable measurements in the database for balance and use ratio are impacted and inappropriate. For two watersheds where user ratios are large, in one (Bush River - 02130701) there is a single large user and for the other (Back River - 02130901) urban use comprises 90% of permitted use.

2.2 Logical Consistency Report: Topology was maintained by using either the ARC/INFO build or clean process. The clean process was used for data layers where ARC determined there were intersections. In order to maintain consistency, the same watershed file was used for intersecting or subdividing all thematic layers.

2.3 Completeness Report: All thematic data layers were summarized for watershed and statewide areas and the acreages compared with DNR, OP, USGS, USCOM and other Departmental hard copy reports. Classifications related to land use and Census data were summarized by County, by State and by watershed and compared with original source hard copy reports.

2.4 Positional Accuracy

Varied by thematic layer.

Watershed file was stated as being accurate to 1:24,000

2.5 Lineage

Source Citation

Originator: Maryland Department of Natural Resources (DNR)

Geographical Information Systems Unit

Watershed Analysis and Management Unit

Publication Date: 1997 and 1998

Title: Maryland Eight Digit Watershed File

Assorted Watershed-Oriented Databases

Publication Information

Publication Place: Maryland Department of Natural Resources

Chesapeake and Coastal Watershed Service

580 Taylor Avenue, E-2

Annapolis, MD 21401

Publisher: Maryland Department of Natural Resources

Chesapeake and Coastal Watershed Service
Source Time period of Content: publication date

Source Citation

Originator: Maryland Department of Environment (MDE)
Water Rights Division
Publication Date: Through the present
Title: Permit Database

Publication Information

Publication Place: Maryland Department Environment
2500 Broening Highway
Baltimore, MD 21224

Publisher: Maryland Department of Environment
Source Time period of Content: publication date

Source Citation

Originator: Maryland Office of Planning (OP)
Publication Date: 1990-Present
Title: Maryland 1994 Land Use Report and Revised 1990 Census Reports

Publication Information

Publication Place: Maryland Office of Planning
301 Preston Street
Baltimore, MD 21201

Publisher: Maryland Office of Planning
Source Time period of Content: publication date

Source Citation

Originator: U.S. Department of Commerce, Economics and Statistics Administration
(USCOM)
Publication Date: 1992
Title: 1990 Census: Maryland, State and County Data
Publication Information
Publication Place: U.S. Department of Commerce
Government Printing Office
Washington, D. C. 20233

Publisher: U.S. Department of Commerce
Source Time period of Content: publication date

Source Citation

Originator: U.S. Department of Commerce, National Oceanic and Atmospheric

Administration (NOAA)
Publication Date: Through 1993
Title: Yearly Precipitation Reports for Maryland
Publication Information
Publication Place: U.S. Department of Commerce, NOAA
Government Printing Office
Washington, D. C. 20233

Publisher: U.S. Department of Commerce
Source Time period of Content: publication date

Source Citation
Originator: U.S. Geological Survey (USGS)
Publication Date: 1990-present
Title: Varying Geological and Water Use Reports
Publication Information
Publication Place: U.S. Geological Survey
Government Printing Office
Washington, D. C. 20233

Publisher: U.S. Geological Survey
Source Time period of Content: publication Date

2.6 Process Step

This database was created using several digital data files to develop a statewide watershed oriented database using PC ARC/INFO. The fields within the database were derived from different thematic data layers containing different scales and methodologies. The fields contain values generated by intersecting the MD DNR watershed files with updated 1990 Census data, 1994 OP land use classification data, MDE and USGS geological and water use data and summarizing selected variables by watershed. Several variables in this database were obtained from previously existing and distributed watershed oriented digital files and hard copy reports.

3. SPATIAL DATA ORGANIZATION INFORMATION

3.1 Indirect spatial reference: MDE Watershed Code

5. ENTITY AND ATTRIBUTE INFORMATION:

5.1 Detailed Description

Attribute Label: MDE8DIGT
Attribute Definition: DNR/MDE watershed eight digit designation
Attribute Definition Source: MD Department of Natural Resources (DNR), see Appendix

Attribute Label: MDE8NAME

Attribute Definition: MD watershed eight digit name (common)

Attribute Definition Source: MD Department of Environment (MDE), see Appendix A

Attribute Label: INRAACRE

Attribute Definition: INRA total watershed acreages

Attribute Definition Source: MD DNR, See Appendix A

Attribute Domain Values: 0 - 535495

Attribute Units of Measure: U.S. acres

Attribute Label: CTYNAME

Attribute Definition: County name abbreviation

Attribute Definition Source: DNR, see Appendix B

Attribute Label: CTYFIPS

Attribute Definition: County Federal Information Processing System (FIPS Code)

Attribute Definition Source: U.S. Department of Commerce (USCOM), see Appendix B

Attribute Label: POPUL95W

Attribute Definition: Total estimated watershed population for the year 1995

Attribute Definition Source: USCOM and updated OP 1990 Census revisions, see
Appendix C

Attribute Domain Values: 0 - 262,492

Attribute Units of Measure: Count

Attribute Label: HOUNITS

Attribute Definition: Total estimated watershed housing units from 1990 Census

Attribute Definition Source: USCOM, see Appendix C

Attribute Domain Values: 0 - 196,680

Attribute Units of Measure: Count

Attribute Label: HOUHLDS

Attribute Definition: Total estimated watershed households from 1990 Census

Attribute Definition Source: USCOM, see Appendix C

Attribute Domain Values: 0 - 187,500

Attribute Units of Measure: Count

Attribute Label: PRECIPIN

Attribute Definition: Estimated average watershed precipitation

Attribute Definition Source: NOAA, see Appendix D

Attribute Domain Values: 0 - 50.0

Attribute Units of Measure: U.S. inches/year

Attribute Label: IMPERV

Attribute Definition: Estimated watershed impervious surface for the year 1995

Attribute Definition Source: OP, 1994 Land Use, see Appendices E and F
Attribute Domain Values: 0 - 41.8
Attribute Units of Measure: Percent

Attribute Label: RUNOFFIN
Attribute Definition: Estimated watershed water runoff in inches
Attribute Definition Source: USGS, see Appendix G
Attribute Domain Values: 0 - 29.3
Attribute Units of Measure: U.S. inches/year

Attribute Label: RUNOFFGAL
Attribute Definition: Estimated watershed water runoff in gallons; taken from previous database and reapportioned to new watershed areas
Attribute Definition Source: calculated, see Appendix G
Attribute Domain Values: 0 - 327,061,826
Attribute Units of Measure: U.S. gallons/day

Attribute Label: PRECIPGAL
Attribute Definition: Percipitation in gallons
Attribute Definition Source: calculated, see Appendix G
Attribute Domain Values: 0 - 1,693,129,191
Attribute Units of Measure: U.S. gallons/day

Attribute Label: RECHARGE
Attribute Definition: Geological type multiplied by recharge rate; taken from previous database and reapportioned to new watershed areas
Attribute Definition Source: literature, see Appendix H
Attribute Domain Values: 0 - 220,669,348
Attribute Units of Measure: U.S. gallons/day

Attribute Label: TOTWELLS
Attribute Definition: Total estimated wells in watershed from 1990 Census
Attribute Definition Source: USCOM, see Appendix C
Attribute Domain Values: 0 - 17,515
Attribute Units of Measure: Count

Attribute Label: PRIVWATGAL
Attribute Definition: Total estimated wells multiplied by county water usage
Attribute Definition Source: calculated, see appendix I
Attribute Domain Values: 0 - 4,412,285
Attribute Units of Measure: U.S. gallons/day

Attribute Label: PRIVWATRET
Attribute Definition: Water well supply returned
Attribute Definition Source: accepted hydrologic rate from literature, see Appendix G

Attribute Domain Values: 0 - 3,529,828
Attribute Units of Measure: U.S. gallons/day

Attribute Label: MDESTD
Attribute Definition: Field established to link MDE8DIGT with MDE watershed permit codes
Attribute Definition Source: MDE

Attribute Label: AGWATUSE
Attribute Definition: Total permitted use of water for agriculture category
Attribute Definition Source: MDE, see Appendix J
Attribute Domain Values: 0 - 8,391,000
Attribute Units of Measure: U.S. gallons/day

Attribute Label: BARRWATUSE
Attribute Definition: Total permitted use of water for barren category
Attribute Definition Source: MDE, see Appendix J
Attribute Domain Values: 0 - 10,577,100
Attribute Units of Measure: U.S. gallons/day

Attribute Label: NOCOMWATUS
Attribute Definition: Total permitted use of water for Non-consumptive category
Attribute Definition Source: MDE, see Appendix J
Attribute Domain Values: 0 - 259,450
Attribute Units of Measure: U.S. gallons/day

Attribute Label: URBWATUSE
Attribute Definition: Total permitted use of water for urban category
Attribute Definition Source: MDE, see Appendix J
Attribute Domain Values: 0 - 10,917,705
Attribute Units of Measure: U.S. gallons/day

Attribute Label: TOTCONUSE
Attribute Definition: Total of all use categories
Attribute Definition Source: MDE, see Appendix J
Attribute Domain Values: 0 - 12,671,550
Attribute Units of Measure: U.S. gallons/day

Attribute Label: PRVWATRECH
Attribute Definition: PRIVWATRET + RECHARGE
Attribute Definition Source: calculated, see Appendix G
Attribute Domain Values: 0 - 221,326,658
Attribute Units of Measure: U.S. gallons/day

Attribute Label: BALANCE

Attribute Definition: Hydrologic balance calculation
Attribute Definition Source: standard hydrologic formula, see Appendix G
Attribute Domain Values: 0 - 176,085,301
Attribute Units of Measure: U.S. gallons/day

Attribute Label: USERATIO
Attribute Definition: Demand divided by Supply
Attribute Definition Source: ratio
Attribute Domain Values: 0 - 2.7733
Attribute Units of Measure: ratio

8. Distribution:

Contact Organization Primary
Maryland Department of Environment
Water Rights Division
Contact Address

Address Type: mailing address
Address: 2500 Broening Highway
City: Baltimore
State or province: Maryland
Postal code: 21224

Contact Voice Telephone: John Smith, P.E., 410-631-4109

Distribution Liability: Although these data have been processed successfully on a computer system at the MD Departments of Environment (MDE) and Natural Resources (DNR), no warranty expressed or implied is made by the MDE regarding the utility of the data on any other system, nor shall the act of distribution constitute such warranty. The MDE will warrant the delivery of this product in computer-readable format by correctly adjusted computer input peripherals.

Standard Order Form:
Maryland Spatial Data Sharing Agreement

Offline Option
Offline media: 3.5" 1.44 meg. floppy disk
Recording format: dBase III+

Digital Form
Digital Transfer Information
format name: dBase III+
Format specification: dbf
Fees: cost of reproduction

METADATA REFERENCE INFORMATION

Metadata Date: 19990218

Metacontact:

Contact Organization Primary
Maryland Department of Environment
Water Rights Division
Contact Address
Address Type: mailing address
address: 2500 Broening Highway
city: Baltimore
State or province: Maryland
Postal code: 21224

Metadata Standard Name: Content Standards for Digital Geospatial
Metadata
Metadata Standard Version: 19940608

APPENDIX A

MDE8DIGT	MDE8NAME (Common Watershed Name)	INRAACRE*
02050301	Conewago Creek	3394
02120201	L. Susequehanna River	24420
02120202	Deer Creek	93164
02120203	Octoraro Creek	22243
02120204	Conowingo Dam Susq R	14778
02120205	Broad Creek	26123
02120101	Atlantic Ocean	59399
02130102	Assawoman Bay	12802
02130103	Isle of Wight Bay	41120
02130104	Sinepuxent Bay	13710
02130105	Newport Bay	32491
02130106	Chincoteague Bay	89297
02130201	Pocomoke Sound	46073
02130202	Lower Pocomoke River	101353
02130203	Upper Pocomoke River	95597
02130204	Dividing Creek	39699
02130205	Nassawango Creek	43875
02130206	Tangier Sound	89646
02130207	Big Annemessex River	29818
02130208	Manokin River	74311
02130301	Lower Wicomico River	79771
02130302	Monie Bay	29580
02130303	Wicomico Creek	19962
02130304	Wicomico River Head	24993
02130305	Nanticoke River	127781
02130306	Marshyhope Creek	78911
02130307	Fishing Bay	130086
02130308	Transquaking River	70932
02130401	Honga River	52737
02130402	Little Choptank	69685
02130403	Lower Choptank	195688
02130404	Upper Choptank	163699
02130405	Tuckahoe Creek	98284
02130501	Eastern Bay	52067
02130502	Miles River	34860
02130503	Wye River	56997
02130504	Kent Narrows	12646
02130505	Lower Chester River	82245
02130506	Langford Creek	27027
02130507	Corsica River	25297
02130508	Southeast Creek	35456
02130509	Middle Chester River	39951

02130510	Upper Chester River	87985
02130511	Kent Island Bay	5755
02130601	Lower Elk River	32460
02130602	Bohemia River	29711
02130603	Upper Elk River	22235
02130604	Back Creek	9514
02130605	Little Elk Creek	15730
02130606	Big Elk Creek	10946
02130607	Christina River	5319
02130608	Northeast River	44424
02130609	Furnace Bay	14100
02130610	Sassafras River	56939
02130611	Stillpond-Fairlee	40913
02130701	Bush River	45836
02130702	Lower Winters Run	8468
02130703	Atkisson Reservoir	29076
02130704	Bynum Run	14583
02130705	Aberdeen Proving Ground	21624
02130706	Swan Creek	16862
02130801	Gunpowder River	24984
02130802	Lower Gunpowder Falls	29239
02130803	Bird River	17736
02130804	Little Gunpowder Falls	37339
02130805	Loch Raven Reservoir	140932
02130806	Prettyboy Reservoir	46455
02130807	Middle River - Browns	9447
02130901	Back River	39127
02130902	Bodkin Creek	6579
02130903	Baltimore Harbor	74897
02130904	Jones Falls	37281
02130905	Gwynns Falls	41710
02130906	Patapsco River L N Br	75755
02130907	Liberty Reservoir	104801
02130908	S Branch Patapsco	54938
02131001	Magothy River	28441
02131002	Severn River	51744
02131003	South River	42294
02131004	West River	19865
02131005	West Chesapeake Bay	52919
02131101	Patuxent River lower	240440
02131102	Patuxent River middle	67905
02131103	Western Branch	59544
02131104	Patuxent River upper	56446
02131105	Little Patuxent River	66214
02131106	Middle Patuxent River	37074
02131107	Rocky Gorge Dam	34208

02131108	Brighton Dam	50595
02139996	Upper Chesapeake Bay	62153
02139997	Middle Chesapeake Bay	97901
02139998	Lower Chesapeake Bay	535495
02140101	Potomac River L tidal	248673
02140102	Potomac River M tidal	47765
02140103	St. Mary's River	54461
02140104	Breton Bay	38449
02140105	St. Clement Bay	33257
02140106	Wicomico River	61009
02140107	Gilbert Swamp	27757
02140108	Zekiah Swamp	69904
02140109	Port Tobacco River	30101
02140110	Nanjemoy Creek	49323
02140111	Mattawoman Creek	62192
02140201	Potomac River U tidal	36255
02140202	Potomac River MO Cnty	88225
02140203	Piscataway Creek	44477
02140204	Oxon Creek	6891
02140205	Anacostia River	92740
02140206	Rock Creek	39268
02140207	Cabin John Creek	16424
02140208	Seneca Creek	82738
02140301	Potomac River FR Cnty	43100
02140302	Lower Monocacy River	194686
02140303	Upper Monocacy River	156501
02140304	Double Pipe Creek	123398
02140305	Catoctin Creek	77063
02140501	Potomac River WA Cnty	58297
02140502	Antietam Creek	118771
02140503	Marsh Run	13460
02140504	Conococheague Creek	41736
02140505	Little Conococheague	10720
02140506	Licking Creek	17719
02140507	Tonoloway Creek	1338
02140508	Potomac River AL Cnty	32551
02140509	Little Tonoloway Creek	9885
02140510	Sideling Hill Creek	14138
02140511	Fifteen Mile Creek	33173
02140512	Town Creek	43411
02141001	Potomac River L N Br	73145
02141002	Evitts Creek	19955
02141003	Wills Creek	38430
02141004	Georges Creek	47695
02141005	Potomac River U N Br	67627
02141006	Savage River	74539

05020201	Youghiogheny River	154255
05020202	Little Youghiogheny R	13110
05020203	Deep Creek Lake	40937
05020204	Casselman River	58588
02130101	Atlantic Ocean	

*INRAACRE: MDE8DIGT includes acreages for five watersheds crossing the State of Maryland boundary into the District of Columbia; these five are essentially the Middle Potomac watersheds. INRAACRE includes only those watershed acreages located within the State of Maryland boundary. Watersheds affected in MDE8DIGT and that cross the MD state boundary line into D.C. are:

MDE8DIGT	MDE8NAME	MD ACRES	TOTAL	DIFF
02140201	Potomac River U tidal	36653	36256	307
02140202	Potomac River MO Cnty	89621	88225	1396
02140204	Oxon Creek	11736	6894	4832
02140205	Anacostia River	116519	92740	23779
02140206	Rock Creek	52761	39269	13492

APPENDIX B

Federal Information Processing Numbers and Initials for Maryland

STATE	CNTYFIPS	COMMON NAME	NAME	
24	001	Allegany County	AL	
24	003	Anne Arundel County		AA
24	005	Baltimore County	BA	
24	009	Calvert County	CA	
24	011	Caroline County	CO	
24	013	Carroll County	CL	
24	015	Cecil County	CE	
24	017	Charles County	CH	
24	019	Dorchester County	DO	
24	021	Frederick County	FR	
24	023	Garrett County	GA	
24	025	Harford County	HA	
24	027	Howard County	HO	
24	029	Kent County	KE	
24	031	Montgomery County	MO	
24	033	Prince George's County	PG	
24	035	Queen Anne's County	QA	
24	037	St. Mary's County	SM	
24	039	Somerset County	SO	
24	041	Talbot County	TA	
24	043	Washington County	WA	
24	045	Wicomico County	WI	
24	047	Worcester County	WO	
24	510	Baltimore City	BC	

APPENDIX C

Methodology for Watershed Estimates for Population for 1995 from 1990 Census data and Maryland Office of Planning (OP) County Population Projections

These variables are from a statewide watershed-oriented database previously distributed in 1997 by the Department of Natural Resources (DNR), Chesapeake and Coastal Watershed Service (CCWS) titled the Maryland Watershed Population Projection Database. These variables come from several sources, comprising essentially three source files: (1) the revised 1997 DNR eight digit watershed file; (2) U.S. Department of Commerce 1990 Census data; and (3) MOP revised and updated reports related to county population and housing estimates and change through the year 2020. Variables within the database were obtained by essentially allocating revised 1990 Census population and housing data and estimated MOP population and housing projections to the sub-watershed level by percent of watershed land acreage within a county.

Methodology for Estimating Watershed Variable Counts from 1990 Census:

Census variables for block groups were allocated to watershed by intersecting Census block groups with the 1997 DNR eight digit watershed file. This intersection was used to determine the ratio of area of block within any given watershed. These ratios were then applied to the census variables to determine the amount of that variable within the watershed. Average variables had to be multiplied out to create a value. These values were then portioned out to the watershed level, after summarizing by a watershed level averages were recalculated.

APPENDIX D

Methodology for Determining Precipitation

Precipitation in inches per year for each watershed was determined using USGS monitoring data over a fifty year average. This monitoring data was intersected with the watersheds and averaged by watershed. Where a monitoring station was unavailable, an average for that meteorologic region was inserted.

APPENDIX E

Land Use Classifications and Definitions have been extracted from Final Report: Preparation of 1990 Land Use/Land Cover Maps and ARC/INFO Digital Data Base, April 15, 1991. A Report Submitted to: Maryland Office of Planning, 301 West Preston Street, Baltimore, MD 21201 and Prepared by: Daft-McCune-Walker, Inc., 200 East Pennsylvania Avenue, Towson, MD 21204.

MARYLAND LAND USE/COVER CLASSIFICATION SCHEME

10 Urban Built-Up

- | | | |
|------------|-----|---|
| and | 11 | Low-density residential - Detached single-family/duplex dwelling units, yards associated areas. Areas of more than 90 percent single-family/duplex dwelling unit, with lot sizes of less than five acres but at least one-half (.2 dwelling units/acre to 2 dwelling units/acre). |
| | 12 | Medium-density residential - Detached single-family/duplex attached single-unit row housing, yards, and associated areas. Areas of more than 90 percent single-family/duplex units and attached single-row housing, with lot sizes of less than one-half acre, but at least one-eighth acre (2 dwelling units/acre to 8 dwelling units/acre). |
| | 13 | High-density residential - Attached single-unit row housing, garden apartments, high-rise apartments/condominiums, mobile home and trailer parks. Areas of more than 90 percent high-density residential units, with more than 8 dwelling units per acre. |
| | 14 | Commercial - Retail and wholesale services. Areas used primarily for the sale of products and services, including associated yards and parking areas. |
| | 15 | Industrial - Manufacturing and industrial parks, including associated warehouses, storage yards, research laboratories, and parking areas. |
| | 16 | Institutional - Elementary and secondary schools, middle schools, junior and senior high schools, public and private colleges and universities, military installations (built-up areas only, including buildings and storage, training, and similar areas), churches, medical and health facilities, correctional facilities, and government offices and facilities that are clearly separable from the surrounding land cover. |
| abandoned) | 17 | Extractive - Surface mining operations, including sand and gravel pits, quarries, coal surface mines, and deep coal mines. Status of activity (active vs. is not distinguished. |
| | 18 | Open urban land - Urban areas who use does not require structures, or urban areas where nonconforming uses characterized by open land have become isolated. Included are golf courses, parks, recreation areas (except areas associated with schools or other institutions), cemeteries, and entrapped agricultural and undeveloped land within urban areas. |
| less | 191 | Large lot subdivision (agriculture) - Residential subdivisions with lot sizes of than 20 acres, but at least 5 acres with a dominant land cover of open fields or pasture. |
| | 192 | Large lot subdivision (forest) - Residential subdivisions with lot sizes of less than |

20 acres, but at least 5 acres with a dominant land cover of deciduous, evergreen or mixed forest.

20 Agriculture

- 21 Cropland - Field crops and forage crops.
- 22 Pasture - Land used for pasture, both permanent and rotated; grass.
- 23 Orchards/vineyards/horticulture/aquaculture - Areas of intensively managed commercial fishing areas (including oyster beds).
- 241 Feeding operations - Cattle feed lots, holding lots for animals, hog feeding lots, poultry houses.
- 242 Agricultural Building breeding and training facilities, storage facilities, built-up areas associated with a farmstead, small farm ponds, commercial fishing areas.
- 25 Row and Garden Crops - Intensively managed truck and vegetable farms and associated areas.

40 Forest

- 41 Deciduous Forest - Forested areas in which the trees characteristically lose their leaves at the end of the growing season.
- 42 Evergreen Forest - Forested areas in which the trees are characterized by persistent foliage throughout the year. Included are such species as white pine, loblolly pine, pond pine, hemlock, southern white cedar, and red pine.
- 43 Mixed Forest - Forested areas in which neither deciduous nor evergreen species dominate, but in which there is a combination of both types.
- 44 Brush - Areas that do not produce timber or other wood products, but may have cut-over timber stands, abandoned agricultural fields, or pasture. These areas are characterized by vegetation types such as sumac, vines, rose, brambles and tree seedlings.

50 Water - Rivers, waterways, reservoirs, ponds, bays, estuaries, and ocean.

60 Wetlands - Forested or nonforested wetlands, including tidal flats, tidal and nontidal marshes and upland swamps and wet areas.

70 Barren Land

- 71 Beaches - Extensive shoreline areas of sand and gravel accumulation, with no vegetative cover or other land use.
- 72 Bare exposed rock - Areas of bedrock exposure, scarps, and other natural accumulations of rock without vegetative cover.
- 73 Bare ground - Areas of exposed ground caused naturally, by construction, or by other cultural processes.

APPENDIX F

Method for Determining Watershed Impervious Acreage

To estimate impervious surface on a watershed basis, Maryland Office of Planning (MOP) 1994 land use digital files were intersected with Department of Natural Resources's (DNR)/Maryland Department of Environment (MDE) digital watershed file (SUB1997) as refined by DNR in 1997. This provided acreage of 1994 MOP land use classifications by land use within each of the states 138 second level or sub-watersheds. Major classifications used by MOP in their 1994 land use inventory were urban, agriculture, forest, water, wetland and barren (See Appendix B). MOP, in their land use inventory, had further subdivided land use files into more distinct categories of use for selected second-level land use classifications. The urban land use classification was subdivided into low density residential (11), medium density residential (12), high density residential (13), commercial (14), industrial (15), institutional, extractive and other urban (16, 17, 18), large lot residential and other (191, 192). It was assumed that the barren classification (71, 72, 73) of use is essentially land that has been stripped for development or includes gravel pits, etc. Therefore, the total acreage in this classification was added to impervious acreage classifications. Consequently, impervious surface became an aggregation of acreage of total urban land use classifications and the acreage in the barren classification of land use. While a case could be made for the acreage in the agriculture land use classification to be also used in calculating impervious surface within a watershed, it was felt that at this point in time it should not be included. Acreage of land use classified as forest, wetland and water was not included in the calculations because it was felt that the important determining factor should be developed land use.

Each individual classification of land use placed in the developed land use category (urban plus barren acreage) was then assigned a percentage of impervious surface to that specific land use. Percentages of impervious surface by type of developed land use were used. Percentage of estimated surface by type of use were from the U.S. Soil Conservation Service TR-55 Manual. Percentages assigned to land use classifications were 25% for low density residential, 38% for medium density residential, 65% for high density residential, 85% for industrial, 72% for commercial, institutional, extractive and for other urban acreage at 72%, large lot residential and other acreage at 12%. Barren land acreage was calculated at 98%. The general formula then used to derive impervious surface acreage is acres of land classified in that use times percent of impervious surface for the use. Acres of impervious surface total includes acres for each estimated use in a watershed.

APPENDIX G

Water Balance Formulas

General:

The water balance formula on which this ground water database is derived was from standard, acceptable, hydrological parameters found in any hydrology textbook. These formulas formed the basis for the data in the database:

$$\begin{aligned}\text{Change in Surface Storage} = & \text{Precipitation} - \text{Runoff} + \text{Base Flow} \\ & + \text{Runoff} \\ & - \text{Evaporation/Transpiration} \\ & - \text{Infiltration}\end{aligned}$$

$$\begin{aligned}\text{Change in Groundwater Storage} = & \text{Infiltration} + \text{Groundwater Movement} \\ & - \text{Groundwater Movement} \\ & - \text{Base Flow} \\ & - \text{Evaporation/Transpiration}\end{aligned}$$

$$\text{Change in Storage} = \text{Surface} + \text{Groundwater}$$

Attribute Formulas:

$$\text{RUNOFFGAL} = (\text{RUNOFFIN in inches}/365) * \text{INRAACRE} * 27,154.3 \text{ (gallons per acre inch)}$$

Source for the conversion figure of 27,154.3 is from the CRC Handbook of Chemistry and Physics, 61st Edition

$$\text{PRECIPGAL} = (\text{PRECIPIN in inches}/365) * \text{INRAACRE} * 27,154.3 \text{ (acre-inches)}$$

$$\text{RECHARGE} = (\text{Recharge Coefficient from Appendix H}) * (\text{INRAACRE})$$

$$\text{PRIVWATGAL} = (\text{TOTWELLS}) * (\text{County Water Usage from Appendix I})$$

$$\text{PRVWATRET} = (\text{PRIVWATGAL}) * (0.80)$$

$$\begin{aligned}\text{BALANCE} = & (\text{RECHARGE}) - (\text{TOTCONUSE}) - (\text{PRIVWATGAL}) + \\ & (\text{PRIVWATRET}) - (0.2 * \text{RECHARGE})\end{aligned}$$

APPENDIX H

Method for Calculating Geological Recharge Rates

An ARC/INFO export file of rock type was obtained from the U.S. Geological Survey (USGS), Towson, MD office. This file was a digital version of the MGS 1:250,000 geology map for MD. This was a draft file and contained data only west of the fall line. This file was intersected with the watershed file and then summarized by watershed and rock type using the ARC/INFO frequency command. The rock types were assigned recharge values given a literature review as shown below. The recharge values were then multiplied by the precipitation to determine recharge rates. The final file was summarized by watershed.

Recharge Coefficients for Rock Types in MD		
<u>Geologic Code</u>	<u>Association Name</u>	<u>Recharge Coefficient (GPD/Acre)</u>
Ca	Antietam Fm	677
Ce	Elbrook Limestone	677
Cf	Frederick Limestone	1172
Ct	Tomstown Dolomite	1172
Cwb	Waynesboro Fm	677
Dshk	Keyser Limestone and Helderberg Fms, Undiv	844
Dch	Chemung, Parkhead, Brallier, and Harrell Fms, Undiv	632
Dch	Harrel Shale-Chemung Fm, Undiv	632
Dh	Hampshire Fm	844
Dh	Hampshire Formation	844
Dhn	Needmore Shale and Hamilton Group, Undiv	844
Do	Oriskany Group	844
Kp	Potomac Group	0
Mg	Greenbrier Fm	844
Mg	Greenbrier Formation	844
Mmc	Mauch Chunk Formation	844
Mp		844
Mp	Pocono Group	844
OCc	Conococheague Limestone	1172
OCg	Grove Limestone	1172
Ocs	St. Paul Group and Chambersburg Limestone, Undiv	1172
Oj	Juniata Fm	632
Om	Martinsburg Fm	632
Ops	Pinesburg Station Dolomite	1172
Orr	Rockdale Run Fm	1172
Os	Stonehenge Limestone	1172
Pap	Pottsville and Allegheny Fms, Undiv	844
Pc	Conemaugh Formation	813
Pd	Dunkard Group	677
Pm	Monongahela Formation	677
Pze	Ellicott City Granodiorite	595

Pzg	Guilford Quartz Monzonite	595
Pzgd	Gabbro and Quartz Diorite Gneiss	632
Pzgg	Gunpowder Granite	595
Pzk	Kensington Quartz Diorite	595
Pzmg	Muscovite Quartz and Monzonite Gneiss	595
Pzn	Norbeck Quartz Diorite	595
Pzp	Pegmatite Dikes	632
Pzpd	Port Deposit Gneiss	595
Pzr	Relay Quartz Diorite	595
Pzw	Woodstock Quartz Monzonite	595
Qtu	Upland Deposits (Western Shore)	0
Ql	Lowland Deposits	0
Qu	Upland Deposits (Eastern Shore)	0
Sc	Clinton Group	641
Sm	McKenzie Fm	677
St	Tuscarora Sandstone	641
Stl	Tonoloway Limestone	1172
Swb	Bloomsburg FM and Willis Creek Shale, Undif	644
Trd	Diabase Sills and Dikes	453
Trg	Gettysburg Shale	453
Trlc	New Oxford Fm (Basal Part)	747
Trno	New Oxford Fm (Upper Part)	747
Trqc	New Oxford Fm (Basal Part)	641
WATER		0
WATER, DEEP CREEK LAKE		0
Xwc	Wissahiykon FM (Albite-Chlorite Schist)	625
bgb	Baltimore Gabbro Complex	435
cc	Cardiff Metaconglomerate	625
cm	Cockeysville Marble	1172
gm	Georgetown Mafic Complex	595
hf	Harpers Fm	453
if	Ijansville Fm	632
if-ms	Ijansville Fm and Marburg Schist, Undiv	595
jg	James River Gneiss	625
lf	Loudoun Fm	453
lmr	Libertytown Metarhyolite	625
mgb	Metagabbro and Amphibolite	435
ms	Marburg Schist	844
pCbg	Baltimore Gneiss	744
pCc	Catoctin Metabasalt	1172
pCg	Cranodiorite and Biotite Granite Gneiss	625
pCmv	Metarhyolite and Associated Pyroclastic Rock	453
pCsr	Swift Run Fm	625
pbs	Peach Bottom Slate	453
scm	Sams Creek Metabasalt	1172
sf	Setters Fm	595

sq	Sugarloaf Mountain Quartzite	625
srl	Silver Run Limestone	844
uf	Urbana Fm	435
ug	Ultramafic and Gabbroic Rock	435
um	Ultramafic Rock	453
vc	Volcanic Complex of Cecil County	744
wbg	Boulder Gneiss Member of Wissahickon Fm	625
wf	Weverton Fm	453
wlps	Lower Pelitic Schist Member of Wissahickon Fm	844
wm	Wakefield Marble	1172
wmg	Metagraywacke Member of Wissahickon Fm	844
wu	Wissahickon Fm, Undiv	844
wups	Upper Pelitic Schist Member of Wissahickon Fm	844

In the coastal plain, the ground water recharge equation used was: Ground Water Recharge = Ground Water Drainage + Change in mean Ground Water Storage x Gravity Yield = 0.259 = 0.021 = 0.480

Estimated Groundwater recharge rates for hydrologic units is as follows:

<u>Rock/Aquifer Type</u>	<u>Average Conditions</u> (GPD/Acre)	<u>Drought Conditions</u> (GPD/Acre)
Carbonate Rocks (REWAI,CL CO 1986)	1172	859
Antietam Creek Area (47% carbonate (MGS RI42))	677	- - -
Meta Volcanic Rocks (REWAI,CL CO 1986)	1172	859
Phyllite (REWAI,CL CO 1986)	453	266
Schist (REWAI,CL CO 1986)	844	438
Triassic Rocks (Sandstone, siltstone, shale) (REWAI, CL CO 1986)	641	344
Marbury & Prettyboy Schist (REWAI, CL CO Water Resource phase I Study)	813	422
Crystalline Rock Aquifers, chiefly Wissahickon, HO & MO Counties (MGS Bulletin 14)	625	491
Ijamsville formation (FR CO)(REWAI 1988)	595	389
Wissahickon formation (Van-Mar Associates 1991)	844	438

New Oxford formation (file FR86G026)	747	491
Tomstown formation (file WA89G022)	- - -	604 (carbonate) 338 (non-carbonate)
Baltimore Gabbro Complex Piedmont Cecil CO (file CE71G018)	744	446
Rock Creek Area quartzose schist (MGS RI 42)	632	- - -

APPENDIX I
Gallons of Water Used per Day by Household by County

County Code	Gallons per Day per Household
AA	209.6
AL	187.2
BA	191.2
BC	199.2
CA	231.2
CE	215.2
CH	229.6
CL	219.2
CO	206.4
DO	188.8
FR	215.2
GA	209.6
HA	218.4
HO	212.0
KE	192.8
MO	214.4
PG	215.2
QA	208.0
SM	220.8
SO	189.6
TA	186.4
WA	196.0
WI	198.4
WO	189.6

Source: MDE, Water Rights Division, personal communication with staff

APPENDIX J

Maryland Water Use Codes and Aggregation of Codes into General Use Categories

<u>Use Code and Definition:</u>	<u>General Use Category*</u>
POTABLE WATER - that used for drinking and sanitary facilities	
101 Municipal Water Supply - Water withdrawn by a municipality and may be supplied to residences, commercial operations, and industries. This category includes all water systems owned by towns, cities, etc. In addition, WSSC, a quasi-government organization, is included.	U
102 Private Water Supplier - Water withdrawn by a private water company and supplied to subdivisions, communities, towns, etc. for residential, commercial, a industrial uses.	U
103 Commercial - Water withdrawn by businesses that exchange, buy, or sell commodities or provide services. Examples are retail stores, furniture refinishing, marinas (for yacht clubs see 105).	U
104 Institutional - Water withdrawn by an organization having a social, educational, or religious purpose. Examples are schools, churches, hospitals, reformatories, military facilities, clubs and associations, nursing homes, post offices, libraries, fire stations and fairgrounds.	U
105 Recreational - Water withdrawn by establishments which provide diversions, amusements or relaxation. Examples are state parks, swim clubs, golf courses, amusement parks, camp grounds, racquet ball clubs, yacht and country clubs.	U
106 Industrial - Water withdrawn by facilities that manufacture or process goods.	U
107 Subdivisions with Individual Wells - Permits issued for two or more building lots of which each has a well.	U
108 Trailer Park/Apartment Building/Condominiums - This category includes trailer parks and apartment buildings which have self-supplied water.	U
109 Residential Heat Pumps - Water withdrawn for the use of residential heat pumps. For commercial and industrial heat pumps, refer to use code 305 and 305. This water use was not included in watershed totals.	D
110 Sewerage Treatment Plants - Water withdrawn by sewerage treatment plants. All sewerage treatment plant water uses are included in this category.	U

111 Livestock watering - Water withdrawn for the raising of cattle, horses, sheep, chickens or other commercially raised animals.	A
112 Agricultural - Water withdrawn for farm potable supplies. Example: migrant labor camps.	A
113 Mining Operations - Potable water supply for mining operations.	B
IRRIGATION - that used for the purpose of artificially applying it to the land	
201 Irrigation, Undefined - Irrigators not covered by the categories below.	A
202 Agricultural - Water applied to crops through a distribution system. Category includes crops for human and animal consumption, tobacco, etc.	A
203 Golf Course - Water required to water the grounds, fill ponds, and otherwise maintain the land developed for golfing.	U
204 Lawns and Parks - Water withdrawn for the sprinkling of commercial, industrial, municipal and institutional lawns and parks.	U
205 Nurseries - Water applied to plants in nurseries. This category includes both indoor and outdoor operations.	U
INDUSTRIAL/COMMERCIAL - Water withdrawn in conjunction with the manufacturing or processing of goods, or the buying, selling or exchanging of commodities.	
302 Food Processing - Water used for the processing of foods, as for example, the washing of fruits and vegetables by canneries.	A
303 Industrial Washing and Separation Processes - Mineral separation processes (flotation), machinery washing (sand and gravel in code 309) and ground water cleanup.	B
304 Mine/Quarry Construction and Dewatering - Water removed from a mine shaft, quarry or construction site for the purpose of working below the natural water table.	B
305 Commercial Heating/Cooling Water - Water withdrawn for ground water heat pumps, as well as cooling water used by commercial operations for air conditioning systems.	U
306 Industrial Heating/Cooling Water - Water withdrawn for ground water heat pumps. In addition, water used for cooling machinery other than electrical generators.	U
307 Commercial Washing Processes - Water used for the washing of clothes, cars, etc.	U

308 Laboratories - Water used in a lab for the purpose of performing experiments, tests and analyses.	U
309 Sand and Gravel Washing - Water used to wash, sort and separate sands and gravels.	B
310 Product Manufacturing - Water involved in the making of a product.	U
311 Fossil Fueled Power Generation - Water required to produce electrical power.	U
312 Nuclear Power Generation - Water required to produce electrical power.	U
313 Hydroelectric Power Generation - Water required to produce electrical power.	D
314 Geothermal Power Generation - Water required to produce electrical power.	U
315 Industrial, undefined - Industrial process not covered by the above categories.	U
316 Commercial, undefined - Commercial processes not covered by the above categories.	U
317 Mining Operations, undefined - Mining processes not covered by the above categories. Examples are dust suppression, underwater dredging.	B
318 Aquaculture - Plant and/or Fish Farm.	A
HYDROSTATIC TESTING AND FIRE PROTECTION	
401 Hydrostatic Testing and Fire Protection	D

General Use Categories Symbols are: (U) for Urban; (D) for Deleted; (A) for Agriculture; (B) for Barren.

Source: MDE, Water Rights Division, Maryland Water Use Code